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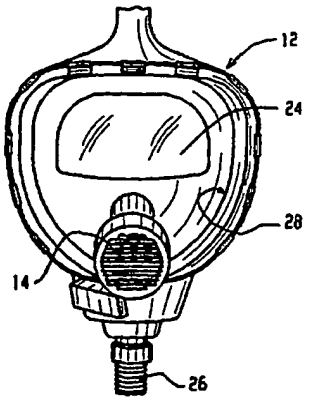
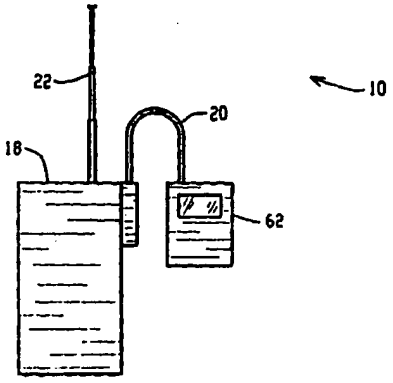
(54) Title: WIRELESS VOICE TRANSMISSION SYSTEM

(57) Abstract

A voice transmission system for a protective face mask (12) is provided, comprising a voice transmitter (14) attached to an external portion of the face mask (12), a radio receiver (16), and a two-way radio (18). The voice transmitter (14) is attached to an external portion of the face mask (12) and transmits the voice of a user of the face mask (12) via a short range radio signal. The radio receiver receives the short range radio signal output by the voice transmitter (14), processes the short range radio signal, and outputs an audio output signal. The two-way radio (i) receives the audio output signal from the radio receiver, amplifies the audio output signal, and transmits the amplified audio output signal to a remotely located receiver, in a transmitting mode, and (ii) receives a broadcast signal from a remotely located transmitter in a receiving mode.





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WIRELESS VOICE TRANSMISSION SYSTEM

Field of the Invention

The present invention relates generally to voice transmission systems for protective face masks and more particularly to a removable voice transmission system for a protective face mask which permits radio communication with a remote location.

Background of the Invention

Protective face masks or respirators for the human face are well known. Persons wearing such respirators often have a need to communicate with one another, particularly in emergency situations. Such emergency situations include fires involving firefighters for whom effective communications with each other and with a command center are critical. Other examples of such emergency situations include military operations wherein military personnel must also communicate with each other and with a central command center.

Because users of these respirators, such as firefighters or military personnel, typically work in hostile environments, it is imperative that the mask remain on the user at all times while the user remains in that environment. Any voice communications systems associated with the mask must also not substantially interfere with the movement of the user. Thus, it is desirable when designing voice communications systems for face masks to eliminate unnecessary wires which might otherwise become entangled with the arms of the user or a stationary object and cause the mask to be pulled away from the face of the user.

A wireless communications apparatus for use in hazardous environments is shown, for example, in U.S. Patent No. 4,885,796 to Loftus et al. The Loftus apparatus includes a face mask which covers the eyes, nose and mouth of the user. A relatively low power transmitter is located entirely within the mask for transmitting a short range signal carrying a communication from the user. A receiver carried on the user's person is tuned to receive the signal of the low powered transmitter and to provide an audio output. A relatively higher powered transceiver is also carried on the user's person. A voice actuated switch is responsive to the output of the receiver to switch the transceiver from a receiving mode to a transmitting mode. A cable connects the voice actuated switch and the transceiver to switch the transceiver between its receiving and transmitting operational modes, and to supply the output of the receiver as the audio input to the transceiver so that the user may communicate with remote receivers tuned to the frequency of the transceiver.

Positioning the transmitter entirely inside the mask as in the Loftus device, however, is less advantageous than locating the transmitter

on the outside of the mask. For example, the addition of any foreign objects inside the mask poses a potential safety concern, as well as a comfort inconvenience for the user. Moreover, transmitters located on the inside of the mask are not as easily removable and adaptable to other masks. Ease of removability is an important feature because the mask is typically cleaned when the transmitter is detached from the mask. In addition, by placing the transmitter on the inside of the mask, the transmitter may not be removed while the user is wearing the mask.

Accordingly, it is an object of the present invention to provide a wireless voice transmission system for a face mask for use in hostile environments. It is a further object of the invention to provide such a system wherein a face mask is provided with a wireless transmitter mounted to and easily removable from the outside of the mask.

Summary of the Invention

A voice transmission system is provided, comprising a face mask, a transmitter module attached to the outside of the mask, a receiver, and a transceiver connected to the receiver by means of an interconnect cable. The transceiver is provided with an antenna to facilitate audio signal transmission and reception to and from a remote location. The voice transmission system permits two-way communications between a user and the remote location.

The mask is provided with an airtight diaphragm located behind the transmitter module. The diaphragm prevents smoke and noxious gases from entering the interior of the face mask yet permits the user's voice to pass therethrough to enable the user to communicate locally with the outside environment. The diaphragm is located on an extension of the face mask which provides a passageway to direct the user's voice toward the outside environment. The transmitter module is removably attachable to the outside of the face mask at the location of the extension.

The transmitter module includes a housing which encloses therein a transducer, a circuit board, and a pair of batteries for supplying power to the transducer and the circuit board. The housing is compartmentalized to isolate these items and to better secure them within the housing. The housing includes a back cover which may be removed to access the transducer, the circuit board and the batteries.

A magnetically actuatable reed switch is contained within the housing for switching power to the transmitter module. A magnet mounted on the outside of the housing and slidable with respect to the reed switch controls the operation of the reed switch to switch the transmitter module on and off.

The voice transmission system operates in either a transmit mode or a receive mode. A voice actuated switch is provided to switch the transceiver between these modes of operation. When the user speaks, the

voice actuated switch is activated to switch the transceiver into a transmit mode. In the absence of the user's voice, the voice actuated switch is deactivated, switching the transceiver into the receive mode.

In the transmit mode, the transmitter module picks up the user's voice after it passes through the diaphragm, processes the received signal, and broadcasts a short range radio signal in the ultra high frequency (UHF) radio range. The receiver receives the short range radio signal output by the transmitter module and processes the signal by downconverting the signal from the ultra high frequency (UHF) radio range to the audio range. The receiver is provided with an amplifier/ speaker assembly to amplify this resulting audio signal and provide local broadcast of the user's voice. The audio signal is also used as an input to the transceiver via the interconnect cable. The transceiver amplifies the audio input and transmits the amplified signal to a remotely located receiver by means of its antenna. The remotely located receiver amplifies the received signal, enabling the user to effectively communicate with the remote location.

In the receive mode of operation of the voice transmission system, a remotely located transmitter transmits a signal to the transceiver which picks up the signal on its antenna and passes the signal on to the receiver via the interconnect cable. The receiver amplifies the audio signal to provide local broadcast of the received communication.

Brief Description of the Drawings

Figure 1 is a perspective view of the individual components of a wireless voice transmission system constructed according to the principles of the present invention;

Figure 2 is a side sectional view of the transmitter/face mask assembly of the voice transmission system of Figure 1;

Figure 3 is a bottom plan view of the transmitter of Figures 1 and 2 with its back cover removed; and

Figure 4 is a bottom plan view of the back cover of the transmitter of Figure 3.

Detailed Description of the Preferred Embodiment

A voice transmission system 10 constructed according to the principles of the present invention is shown in Figure 1. The voice transmission system 10 includes a mask 12, a transmitter module 14 attached to the outside of the mask, a receiver 16, and a transceiver 18 connected to the receiver 16 by means of an interconnect cable 20. The transceiver 18 is provided with an antenna 22. The receiver and transceiver are typically worn at belt level by the user, although other wearing locations on the user are contemplated, such as about the shoulder area of the user.

The mask 12 is provided with a transparent viewing shield 24 through which the user may see. The mask is also provided with an air tube 26 which connects a supply of fresh oxygen (not shown) to the mask. A resilient seal 28 surrounds the mask 12 which seats against the face of the user to isolate smoke or noxious gases from the respiratory system of the user.

An airtight diaphragm 30 is located behind the transmitter module 14 (see Figure 2). The diaphragm prevents smoke and noxious gases from entering the interior of the face mask yet permits the user's voice to pass therethrough to enable the user to communicate locally with the outside environment. The diaphragm is located on an extension 32 of the face mask 12 which provides a passageway to direct the user's voice toward the outside environment.

The transmitter module 14 attaches to the outside of the face mask 12 at the location of the extension 32. As shown in Figure 2, the extension 32 is provided with threads or ridges 34 on the portion thereof which forms the passageway for the user's voice. The transmitter module 14 fits snugly within the passageway and is secured to the face mask using any number of known techniques. Some of these known techniques include spring loaded compression, screw-in, pop-in, snap-on and hinged attachment. Examples of some of these manners of attachment are shown in commonly owned U.S. Patent No. 5,138,666 an U.S. Application Serial Nos. 07/792,804 and 08/038,456, the text of each of which is hereby incorporated as if fully set forth herein. These types of attachment techniques permit the transmitter module 14 to be easily attached to and detached from the face mask extension while the mask remains on the face of the user. Moreover, these attachment techniques permit the voice transmitter module to be removably detachable from the face mask without removing or altering the voice diaphragm.

The transmitter module 14 includes a housing 36 which encloses therein a transducer 38 (*e.g.* a microphone), a circuit board 40, and a pair of batteries 42 for supplying power to the transducer and the circuit board. The housing is compartmentalized to isolate the transducer 38, the circuit board 40, and the batteries 42 from each other and to better secure these items within the housing. The housing is preferably made of a thermoplastic material which may be manufactured, for example, by an injection molding process. The batteries in the preferred embodiment each provide a potential of three volts.

The transmitter module housing 36 includes a back cover 44 which may be removed to access the transducer 38, the circuit board 40 and the batteries 42 (see Figures 3 and 4). The cover 44 is secured to the remainder of the housing 36 by means of screws (not shown) through holes 46 in the cover and corresponding threaded holes 48 in the housing. The back cover 44 is also provided with an annular ridge 50 which seats against

the face mask extension 32 when the transmitter module 14 is installed in the face mask 12. A space 52 is thereby created between the back cover 42 and the airtight diaphragm 30, permitting the diaphragm to vibrate in response to the user's voice. Vibration of the diaphragm must be permitted for the diaphragm to allow the user's voice to pass therethrough to the transducer 38 in an audible fashion.

A magnetically actuatable reed switch 54 is contained within the housing 36 for switching the transmitter module on and off. A magnet (not shown) is mounted on the outside of the housing such that it is slidable with respect to the reed switch 54. By sliding the magnet back and forth, the reed switch may be selectively actuated and deactuated, thereby switching the transmitter module on and off.

When the transmitter module 14 is turned on, the voice transmission system may operate in either a transmit mode or a receive mode. In the transmit mode, the transducer 38 picks up the user's voice after it passes through the diaphragm 30. Circuitry on the circuit board 40 processes this audio signal and in response broadcasts a short range radio signal in the ultra high frequency (UHF) radio range. In the preferred embodiment, the transmitter transmits the short range radio signal in the 1.0 - 2.4 gigahertz range. This frequency range is outside the range used by many commercially available radio communications products, such as one-way baby monitors and two-way walkie-talkies. Accordingly, broadcasting the short range radio signal in the gigahertz frequency range will eliminate interference with such devices. Further, short range radio signals in this range are more likely to penetrate structural components such as walls in environments in which the voice transmission system 10 is likely to be used.

The receiver 16 receives the short range radio signal output by the transmitter module 14 and processes the signal by downconverting the signal from the ultra high frequency (UHF) radio range to the audio range. The receiver is provided with an amplifier/speaker assembly to amplify this resulting audio signal and provide local broadcast of the user's voice. The audio signal is also used as an input to the transceiver 18 via the interconnect cable 20.

The transceiver 18 may be one such as that disclosed in U.S. Patent No. 4,885,796 to Loftus, the text of which patent is hereby incorporated as if fully set forth herein. The transceiver amplifies the audio input and transmits the amplified signal to a remotely located receiver by means of its antenna 22. The remotely located receiver amplifies the received signal, enabling the user to effectively communicate with the remote location.

In the receive mode of operation of the voice transmission system, a remotely located transmitter transmits a signal to the transceiver 18 which picks up the signal on its antenna 22 and passes the signal on to the

receiver 16 via the interconnect cable 20. The receiver amplifies the audio signal to provide local broadcast of the received communication.

The transceiver 18 must be switched between the transmit and receive mode of operation. To accomplish this effect, a voice actuated switch is provided for the transceiver. When the user speaks, the voice actuated switch is activated to switch the transceiver into a transmit mode. In the absence of the user's voice, the voice actuated switch is deactivated, switching the transceiver into the receive mode.

Accordingly, the preferred embodiment of a voice transmission system for a protective respirator has been described. With the foregoing description in mind, however, it is understood that this description is made only by way of example, that the invention is not limited to the particular embodiments described herein, and that various rearrangements, modifications and substitutions may be implemented without departing from the true scope of the invention as hereinafter claimed.

What is claimed is:

1. A voice transmission system for a protective face mask, comprising:

a voice transmitter module attached to an external portion of the face mask for transmitting the voice of a user of the face mask via a short range radio signal;

a radio receiver for receiving said short range radio signal output by said voice transmitter module, processing said short range radio signal, and outputting an audio output signal; and

a transceiver for (i) receiving said audio output signal from said radio receiver, amplifying said audio output signal, and transmitting said amplified audio output signal to a remotely located receiver, in a transmitting mode, and for (ii) receiving a broadcast signal from a remotely located transmitter, in a receiving mode.

2. The voice transmission system of claim 1, wherein said voice transmitter module is removably detachable from said face mask.

3. The voice transmission system of claim 2, further comprising a switch for switching the transceiver between receiving and transmitting modes.

4. The voice transmission system of claim 3, wherein said switch is voice actuated, switching the transceiver into transmitting mode when detecting the user's voice and switching the transceiver into receiving mode when not detecting the user's voice.

5. The voice transmission system of claim 3, further providing local voice amplification in the form of a speaker driven by said radio receiver.

6. The voice transmission system of claim 3, wherein the face mask is provided with a voice diaphragm, and said voice transmitter module is removably detachable from the face mask without removing or altering said voice diaphragm.

7. The voice transmission system of claim 3, further comprising a magnetically actuatable reed switch contained within the voice transmitter module and a magnet mounted to the outside of the module and slidable with respect to said reed switch.

8. The voice transmission system of claim 3, wherein said transmitter module transmits said short range radio signal in the ultra high frequency (UHF) radio range.

9. The voice transmission system of claim 8, wherein said voice transmitter module transmits said short range radio signal in the 1.0 - 2.4 gigahertz range.

10. The voice transmission system of claim 8, wherein said receiver downconverts said short range radio signal from the ultra high frequency (UHF) radio range to the audio frequency range.

11. A communications system, comprising:

a protective face mask sealable against the face of a user;

a voice transmitter module attached to an external portion of said face mask for transmitting the voice of a user of said face mask via a short range radio signal;

a radio receiver for receiving said short range radio signal output by said voice transmitter module, processing said short range radio signal, and outputting an audio output signal; and

a transceiver for (i) receiving said audio output signal from said radio receiver, amplifying said audio output signal, and transmitting said amplified audio output signal to a remotely located receiver, in a transmitting mode, and for (ii) receiving a broadcast signal from a remotely located transmitter, in a receiving mode.

12. The voice transmission system of claim 11, wherein said voice transmitter module is removably detachable from said face mask.

13. The voice transmission system of claim 12, further comprising a switch for switching the transceiver between receiving and transmitting modes.

14. The voice transmission system of claim 13, wherein said switch is voice actuated, switching the transceiver into transmitting mode when detecting the user's voice and switching the transceiver into receiving mode when not detecting the user's voice.

15. The voice transmission system of claim 13, further providing local voice amplification in the form of a speaker driven by said radio receiver.

16. The voice transmission system of claim 13, wherein said face mask is provided with a voice diaphragm, and said voice transmitter module

is removably detachable from said face mask without removing or altering said voice diaphragm.

17. The voice transmission system of claim 13, further comprising a magnetically actuatable reed switch contained within the voice transmitter module and a magnet mounted to the outside of the module and slidable with respect to said reed switch.

18. The voice transmission system of claim 13, wherein said transmitter module transmits said short range radio signal in the ultra high frequency (UHF) radio range.

19. The voice transmission system of claim 18, wherein said voice transmitter module transmits said short range radio signal in the 1.0 - 2.4 gigahertz range.

20. The voice transmission system of claim 18, wherein said receiver downconverts said short range radio signal from the ultra high frequency (UHF) radio range to the audio frequency range.

AMENDED CLAIMS

[received by the International Bureau on 18 September 1995 (18.09.95); original claims 1, 3, 6, 11, 13 and 16 amended; original claims 2, 12 cancelled; new claims 21-25 added; remaining claims unchanged (3 pages)]

1. A voice transmission system for a protective face mask, comprising:

a voice transmitter module at least partially enclosing a microphone and removably attachable to an external portion of the face mask for transmitting the voice of a user of the face mask via a short range radio signal;

a radio receiver for receiving said short range radio signal output by said voice transmitter module, processing said short range radio signal, and outputting an audio output signal; and

a transceiver for (i) receiving said audio output signal from said radio receiver, amplifying said audio output signal, and transmitting said amplified audio output signal to a remotely located receiver, in a transmitting mode, and for (ii) receiving a broadcast signal from a remotely located transmitter, in a receiving mode.

3. The voice transmission system of claim 1, further comprising a switch for switching the transceiver between receiving and transmitting modes.

4. The voice transmission system of claim 3, wherein said switch is voice actuated, switching the transceiver into transmitting mode when detecting the user's voice and switching the transceiver into receiving mode when not detecting the user's voice.

5. The voice transmission system of claim 3, further providing local voice amplification in the form of a speaker driven by said radio receiver.

6. The voice transmission system of claim 3, wherein the face mask is provided with a voice diaphragm, said voice transmitter module being attached to an external portion of said face mask opposite said voice diaphragm, [and] said voice transmitter module is removably detachable from the face mask without removing or altering said voice diaphragm.

7. The voice transmission system of claim 3, further comprising a magnetically actuatable reed switch contained within the voice transmitter module and a magnet mounted to the outside of the module and slidable with respect to said reed switch.

8. The voice transmission system of claim 3, wherein said transmitter module transmits said short range radio signal in the ultra high frequency (UHF) radio range.

9. The voice transmission system of claim 8, wherein said voice transmitter module transmits said short range radio signal in the 1.0 - 2.4 gigahertz range.

10. The voice transmission system of claim 8, wherein said receiver downconverts said short range radio signal from the

ultra high frequency (UHF) radio range to the audio frequency range.

11. A communications system, comprising:

a protective face mask sealable against the face of a user;

a voice transmitter module at least partially enclosing a microphone and removably attached to an external portion of said face mask for transmitting the voice of a user of said face mask via a short range radio signal;

a radio receiver for receiving said short range radio signal output by said voice transmitter module, processing said short range radio signal, and outputting an audio output signal; and

a transceiver for (i) receiving said audio output signal from said radio receiver, amplifying said audio output signal, and transmitting said amplified audio output signal to a remotely located receiver, in a transmitting mode, and for (ii) receiving a broadcast signal from a remotely located transmitter, in a receiving mode.

13. The voice transmission system of claim 11, further comprising a switch for switching the transceiver between receiving and transmitting modes.

14. The voice transmission system of claim 13, wherein said switch is voice actuated, switching the transceiver into transmitting mode when detecting the user's voice and switching the transceiver into receiving mode when not detecting the user's voice.

15. The voice transmission system of claim 13, further providing local voice amplification in the form of a speaker driven by said radio receiver.

16. The voice transmission system of claim 13, wherein said face mask is provided with a voice diaphragm, said voice transmitter module being attached to an external portion of said face mask opposite said voice diaphragm, said voice transmitter module is removably detachable from said face mask without removing or altering said voice diaphragm.

17. The voice transmission system of claim 13, further comprising a magnetically actuatable reed switch contained within the voice transmitter module and a magnet mounted to the outside of the module and slidable with respect to said reed switch.

18. The voice transmission system of claim 13, wherein said transmitter module transmits said short range radio signal in the ultra high frequency (UHF) radio range.

19. The voice transmission system of claim 18, wherein said voice transmitter module transmits said short range radio signal in the 1.0 - 2.4 gigahertz range.

20. The voice transmission system of claim 18, wherein said receiver downconverts said short range radio signal from the

ultra high frequency (UHF) radio range to the audio frequency range.

21. A personal communications system, comprising:

a first transceiver module attachable to a user's person proximate the user's mouth for (i) receiving the user's voice and upconverting the user's voice from the audio range to a short range radio signal and transmitting the short range radio signal, in a transmitting mode, or (ii) receiving a short wave radio signal and downconverting said short wave radio signal from the short wave radio range to the audio range, in a receive mode, said first transceiver including a speaker attachable to the user's person proximate the user's ear for broadcasting said downconverted audio signal; and

a second transceiver module attachable to the same user's person for (i) receiving an audio signal and upconverting the audio signal to a short wave radio signal and broadcasting said short wave radio signal to said first transceiver, in a receiving mode, or (ii) receiving a short wave radio signal from said first transceiver and downconverting said short wave radio signal to the audio range, in a transmitting mode, said second transceiver including an amplifier/speaker assembly to amplify said downconverted signal to provide local broadcast of the user's voice.

22. The communications system of claim 21, further comprising a two-way radio connected to said second transceiver for providing long distance communications capabilities between said second transceiver and a remotely located transmitter/receiver.

23. The communications system of claim 22, further providing local voice amplification in the form of a speaker driven by said second transceiver.

24. The voice transmission system of claim 22, wherein said first and second transceiver modules transmit said short range radio signals in the ultra high frequency (UHF) radio range.

25. The communications system of claim 24, wherein said first and second transceiver modules transmit said short range radio signal in the 1.0 - 2.4 gigahertz range.

STATEMENT UNDER ARTICLE 19

The proposed amendments to the claims more clearly define over the references cited in the Search Report.

Amended claims 1 and 11 recite a voice transmitter module at least partially enclosing a microphone and removably attached to (claims 11-20) or removably attachable to (claims 1-10) an external portion of a protective face mask.

Neither U.S. Patent No. 4,885,796 to Loftus nor U.S. Patent No. 5,060,308 to Bieback discloses or suggests the claimed invention. Loftus discloses a communications apparatus for a face mask having a transmitter 40 which includes a microphone MK-1 and which is mounted inside the mask (col. 3, lines 46-51; Figure 3). Bieback discloses a communication system for attachment to a firefighter's face mask comprising an internal microphone unit 30 and an external speaker unit 21 (col. 6, par. 3-4; Figure 6). The Bieback microphone unit 30 includes a microphone 47 which is mounted inside the mask.

Bieback discloses an alternative embodiment (Figure 9) in which a piezoelectric pick-up element is mounted outside the mask. However, in this case the pick-up element is fixedly mounted to a glass/plastic lens portion of the mask, unlike the claimed invention which removably attaches the voice transmitter module to an external portion of the mask. In Bieback, a bonding agent 34 such as epoxy is required to mount the unit to the lens (see top of col. 7). Therefore, the Bieback unit is not removably detachable from the mask.

Claim 21 recites a personal communications system which includes a first transceiver including a speaker attachable to the user's person proximate the user's ear for broadcasting a

down-converted audio signal; and a second transceiver including an amplifier/speaker assembly to amplify the downconverted signal to provide local broadcast of the user's voice. Ohhashi fails to disclose such a system. Ohhashi discloses a system wherein two transceivers 1 and 2 are connected by a transceiver 3. The transceivers are adapted to be worn by two separate persons (see col. 1, lines 61-66). The transceiver 3 includes a radio receiver R and a radio transmitter T so that it is apparent that the transceiver 3 communicates with transceivers 1 and 2 via radio waves.

The claimed invention, on the other hand, recites a personal communications system which operates in a transmitting mode wherein a first transceiver attachable to a user's person proximate the user's mouth receives the user's voice, converts it to a radio signal, and transmits the radio signal to a second transceiver attachable to the same user's person which receives the radio signal, converts it to an audio signal, and amplifies and locally broadcasts the user's voice through a speaker. Alternatively, the personal communications system operates in a receiving mode wherein the first transceiver receives a radio signal from the second transceiver and downconverts it to the audio range so that it may be heard by the user through a speaker proximate the user's ear.

Thus, in either mode of operation, the output of the claimed invention is an audio signal which is either heard by the user (receiving mode) or is locally broadcast (transmitting mode). To permit this type of operation, the claimed personal communications system includes speakers for each of the first and second transceivers to be worn by separate users, which Ohhashi does not provide. In the receive mode, each of Ohhashi's transceivers 1 and 2 can broadcast an audio signal to the wearer which has been downconverted from a received radio signal, but in a transmit mode, each of his transceivers 1 and 2 broadcasts a radio, and not an audio, signal.

In light of the foregoing, it respectfully submitted that the application is in condition for allowance.

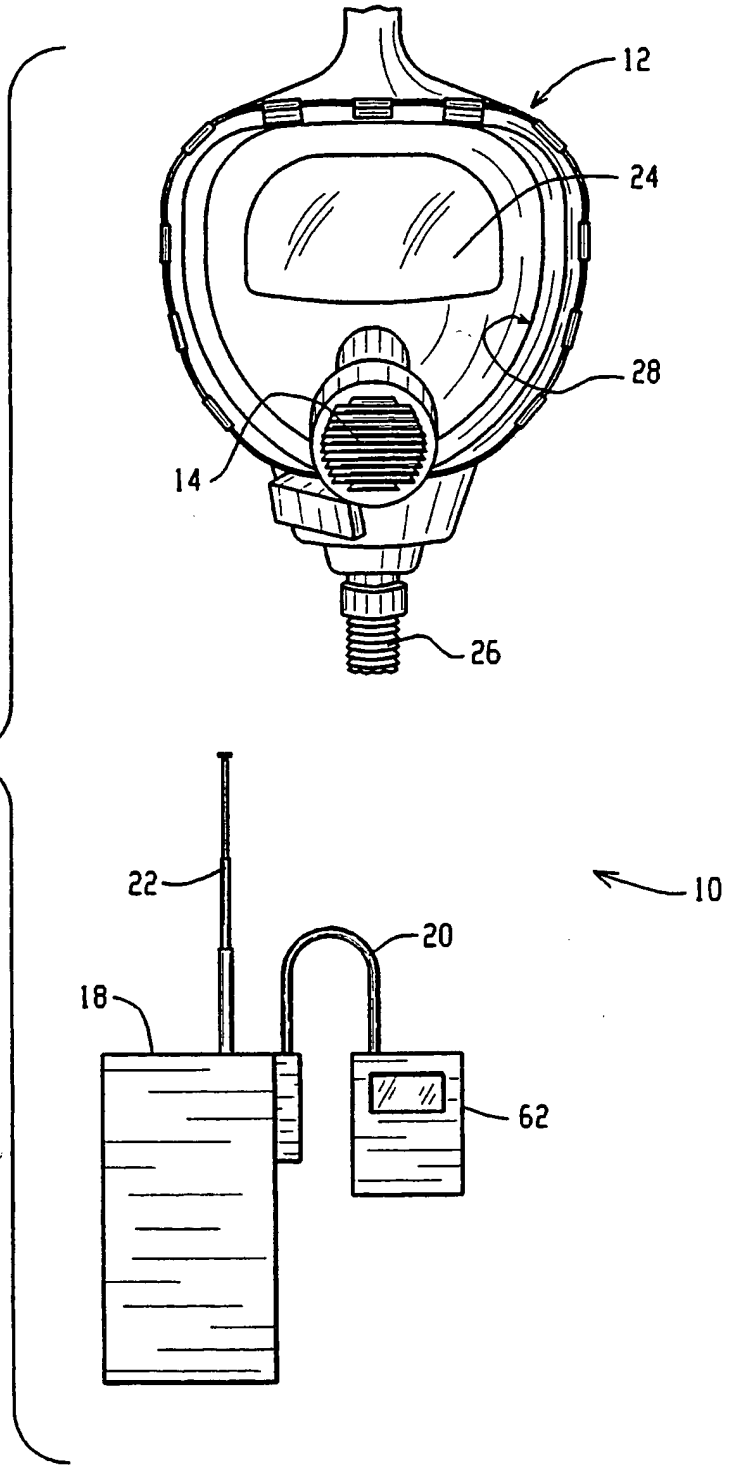


FIG. 1

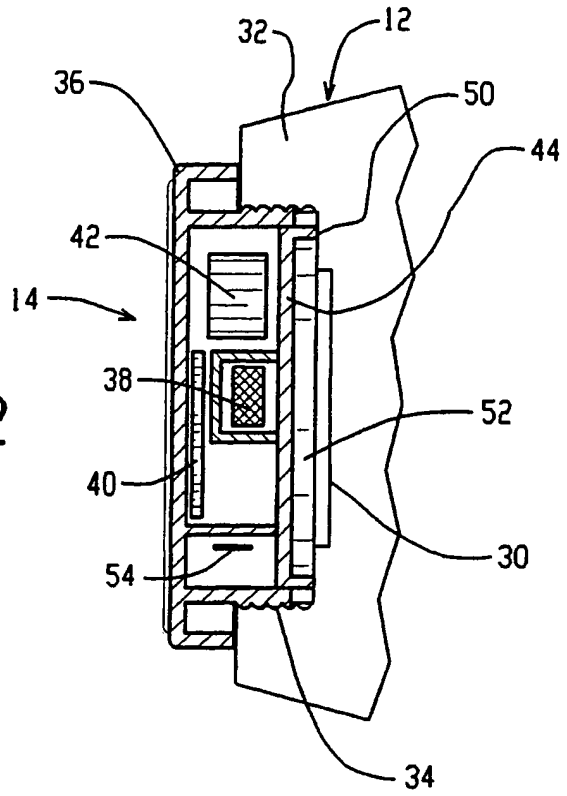


FIG. 2

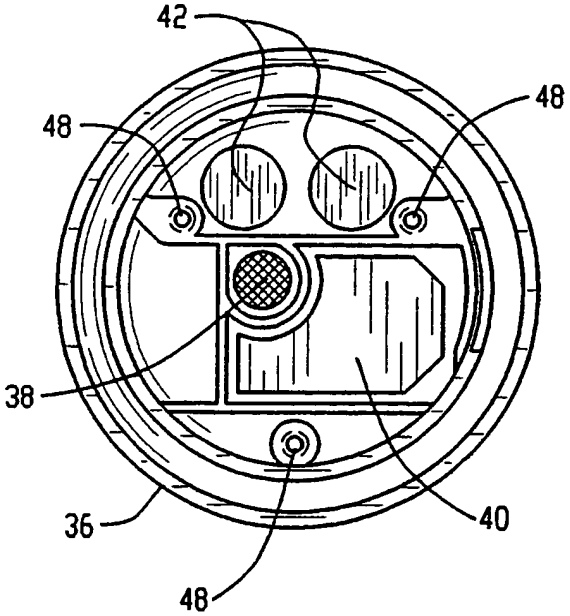


FIG. 3

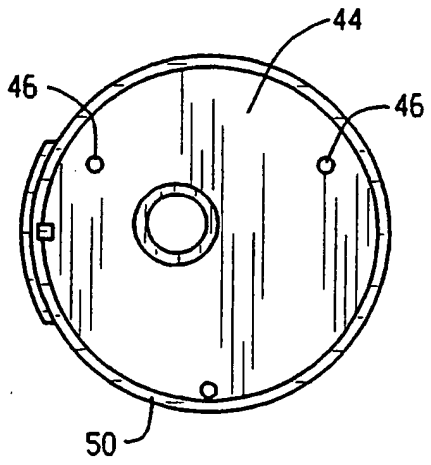
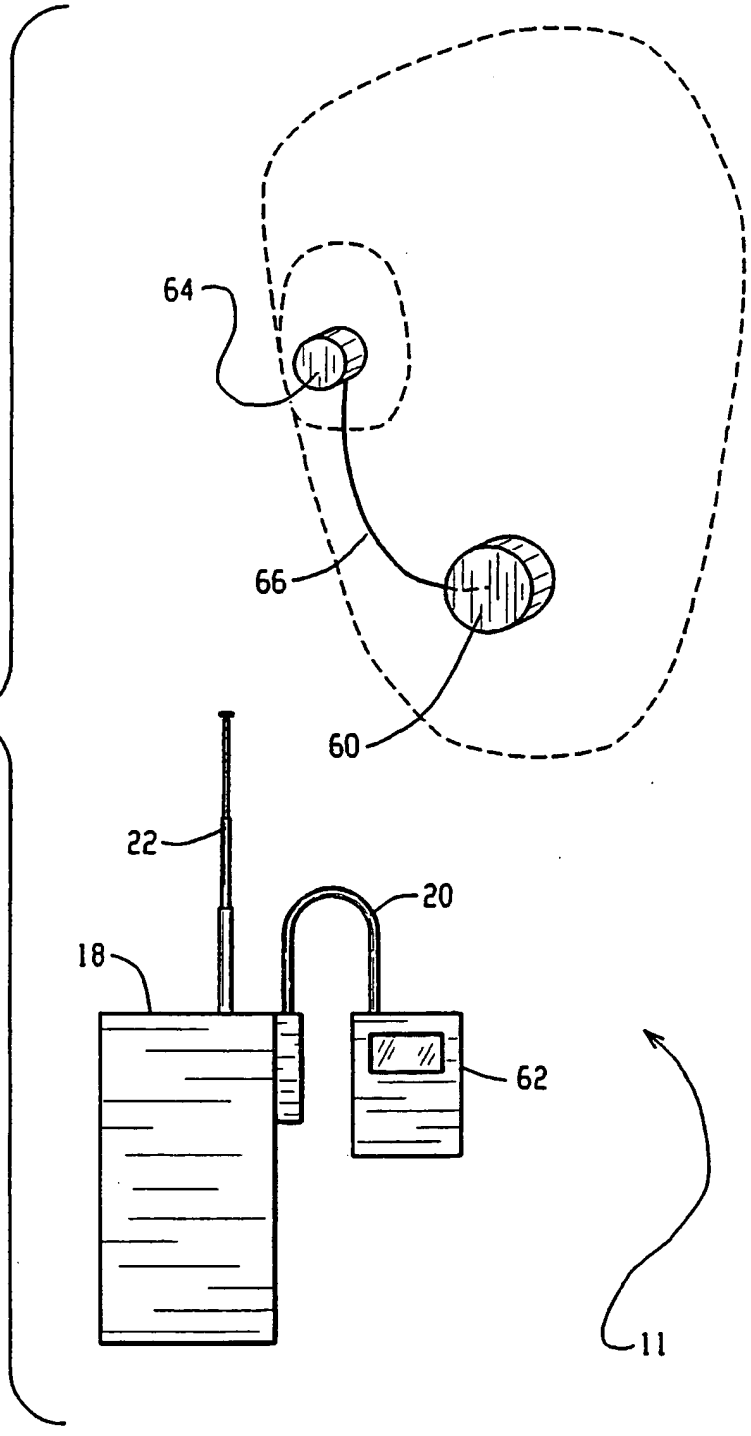


FIG. 4

FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/05489

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :H04B 1/40
US CL :455/74
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 455/74, 66, 89, 90, 346, 348, 349, 62, 128, 41, 100

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 5,060,308 (Bieback) 22 October 1991, see FIGS. 1-3.	1-20
Y	US, A, 3,916,312 (Campbell) 28 October 1975, see FIG. 3.	1
Y	US, A, 4,885,796 (Loftus et al.) 05 December 1989, see FIGS. 1-3 and Abstract.	1-20
Y	US, A, 4,980,926 (Noetzel) 25 December 1990, see FIGS. 1, and 3-8.	1
X ---- Y	US, A, 4,392,243 (Ohhashi et al.) 05 July 1983, see FIGS. 1-4.	21-23 -------- 24-25

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be part of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search
09 JUNE 1995

Date of mailing of the international search report
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PCT/US95/05489

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,491,699 (Walker) 01 January 1985 see FIGS. 1,3 and 5	1